Check List the journal of biodiversity data

NOTES ON GEOGRAPHIC DISTRIBUTION

Check List 16 (3): 737–741
https://doi.org/10.15560/16.3.737

PENSOFT

The first record of the coprophilous fungi *Utharomyces epallocaulus* Boedijn ex P.M. Kirk & Benny (Mucoromycotina, Mucorales, Pilobolaceae) in Brazil

Maria Helena Alves[1], Mateus Oliveira da Cruz[1,2], André Luiz Cabral Monteiro de Azevedo Santiago[2]

1 Departamento de Biologia, Universidade Federal do Piauí, Campus Ministro Reis Velloso, Av. São Sebastião, 2819, 64202-020, Parnaíba, PI, Brazil. **2** Programa de Pós-graduação em Biologia de Fungos, Departamento de Micologia, Universidade Federal de Pernambuco, Av. Professor Nelson Chaves, s/n, 50670-420, Recife, PE, Brazil.
Corresponding author: André Luiz Cabral Monteiro de Azevedo Santiago, andrelcabarl@msn.com

Abstract
During a study on coprophilous fungus diversity in the State of Piauí, Brazil, *Utharomyces epallocaulus* Boedijn ex P.M. Kirk & Benny was isolated from rabbit dung. Morphologically, this species is characterized by the production of sporangiophores that exhibit a subsporangial vesicle and that emerge from a trophocyst immersed in the substrate. The sporangia are black, with resistant wall, and the sporangiospores are globose to subglobose. The taxon is described and illustrated for the first time in Brazil. Aspects of its morphology are discussed.

Keywords
Mucoromyceta, Northeastern Brazil, rabbit dung, taxonomy, zygosporic fungi.

Academic editor: Claudia López Lastra | Received 3 March 2020 | Accepted 26 May 2020 | Published 16 June 2020

Citation: Alves MH, Cruz MO, Santiago ALCMA (2020) The first record of the coprophilous fungi *Utharomyces epallocaulus* Boedijn ex P.M. Kirk & Benny (Mucoromycotina, Mucorales, Pilobolaceae) in Brazil. Check List 16 (3): 737–741. https://doi.org/10.15560/16.3.737

Introduction

The family Pilobolaceae Corda, belonging to the phylum Mucoromycota Doeweld and subphylum Mucoromycotina Benny (Tedersoo et al. 2018), traditionally comprised the genera *Pilobolus* Tode, *Pilaira* Tiegh., and *Utharomyces* Bordijn ex P.M. Kirk & Benny (Kirk and Benny 1980). However, molecular data produced by O'Donnell et al. (2001) and Voigt and Wöstemeyer (2001) suggested that *Pilaira* does not belong to Pilobolaceae. Foos et al. (2011) carried out a phylogenetic study that agreed with this suggestion, and later Benny et al. (2014) considered *Pilaira* to be a member of Mucoraceae Fr.

Morphologically, species of Pilobolaceae are characterized by the production of sporangiophores that arise from a trophocyst and exhibit a subsporangial vesicle below a black sporangium with a resistant wall (Voigt 2012). Species of this family are primarily saprobes on dung (Foos et al. 2011; Voigt 2012), although there are a few reports of isolation of *Utharomyces epallocaulus* Boedijn ex P.M. Kirk & Benny from soil (deposited in the CBS 329.73) and humus (Wallace and Dickinson 1978).

The genus *Utharomyces* is monospecific and was proposed by Boedijn (1959) to accommodate *U. epallocaulus*. However, this name was found to be invalid

©The authors. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

because the holotype was not indicated by Boedijn, according to the Article 37.1 of the ICBN (Greuter et al. 2000); nevertheless, this name was later validated by Kirk and Benny (1980). Sarbhoy et al. (1974) described a new taxon, *U. indicus* A.K. Sarbhoy, S.N. Singh & D.K. Agarwal, based on morphological differences, including short sporangiophores, obovoid columellae, and globular sporangiospores. However, *U. indicus* has been synonymized with *U. epallocaulus* (Kirk and Benny 1980).

Utharomyces epallocaulus is characterized by producing sporangiophores that emerge from a trophocyst immersed in the substrate and exhibit a subsporangial vesicle. The sporangia are black, with resistant wall and the sporangiospores are globose to subglobose. Unlike *Pilobolus*, *U. epallocaulus* does not forcibly shoot their sporangia when mature. This species has been recorded in Africa continent, Bahamas, Ghana, India, Indonesia, Mexico, Republic of China, United States, and Venezuela (Dring 1960; Kirk and Benny 1980; Delgado Ávila et al. 2005).

The present study aims to report, describe and illustrate *U. epallocaulus* isolated from rabbit dung collected in northeastern Brazil.

Methods

Samples of rabbit (*Oryctolagus cuniculus* Lilljeborg, 1874) dung were collected in the city of Parnaíba (02° 54′17″S, 041°46′36″W), Piauí state (Fig. 1), in April 2019, with the aid of tweezers previously dipped in 70% alcohol and packed in plastic bags. In the laboratory, the samples were distributed in Petri dishes containing filter paper moistened with sterile distilled water and incubated at room temperature (28 ± 2 °C) under alternation of light and dark. Fragments of mycelium were removed directly from the samples under a stereomicroscope and transferred to Petri dishes with potato dextrose agar (Benny 2008) plus chloramphenicol (80 mg/L). Identification was based on macroscopic (color, aspect, and diameter of the colonies) and microscopic (microstructural) characters according to Boedijn (1959), Kirk and Benny (1980), and Delgado Ávila et al. (2005). One culture of *U. epallocaulus* was deposited in the Micoteca URM from the Federal University of Pernambuco, Brazil.

Results

***Utharomyces epallocaulus* Boedijn ex P.M. Kirk & Benny**, Transactions of the British Mycological Society 75 (1): 124. 1980.
Figure 2

New record. BRAZIL • 1 specimen; Piauí, Parnaíba; 02° 54′17″S, 041°46′36″W; 29 April 2019; Mateus Oliveira da Cruz leg.; in rabbit dung; URM 8129.

Identification. Colonies white with black spots corresponding to the sporangia, growing 3 cm in diameter after five days in BDA at 28 °C. Reverse light cream-colored. Trophocysts hyaline, submerged in the substrate, non-apophysate, subglobose, thin- and smooth-walled, separated from the aerial mycelium by a septum at the base of the sporangiophore, 80–110 × 97–180 µm. Sporangiophores hyaline, erect, long, ascending, without septation, with positive phototropism, smooth-walled, 8–13.5 µm in diameter. Subsporangial vesicles hyaline, globose or ovoid, thin- and smooth-walled, 54–120 µm in diameter. Sporangia multispored, initially white and becoming black, globose when young and hemispherical at maturity, with an equinulate and persistent wall, 40–60 × 30–130 µm. Columellae hyaline, dolabriform to globose, smooth-walled, thin and rapidly collapsing,

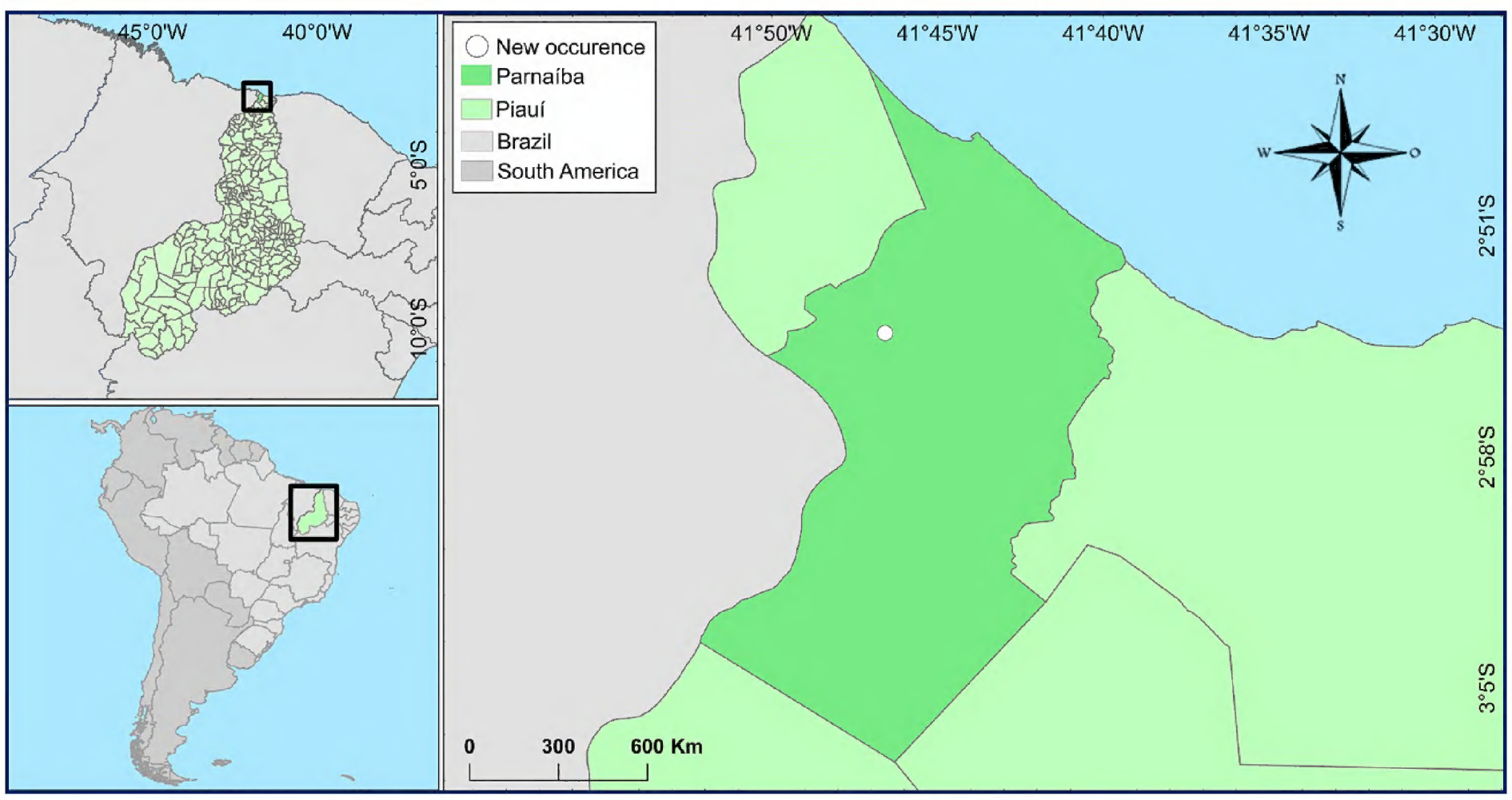

Figure 1. The location in Parnaíba city, Piauí, Brazil, where *Utharomyces epallocaulus* was found.

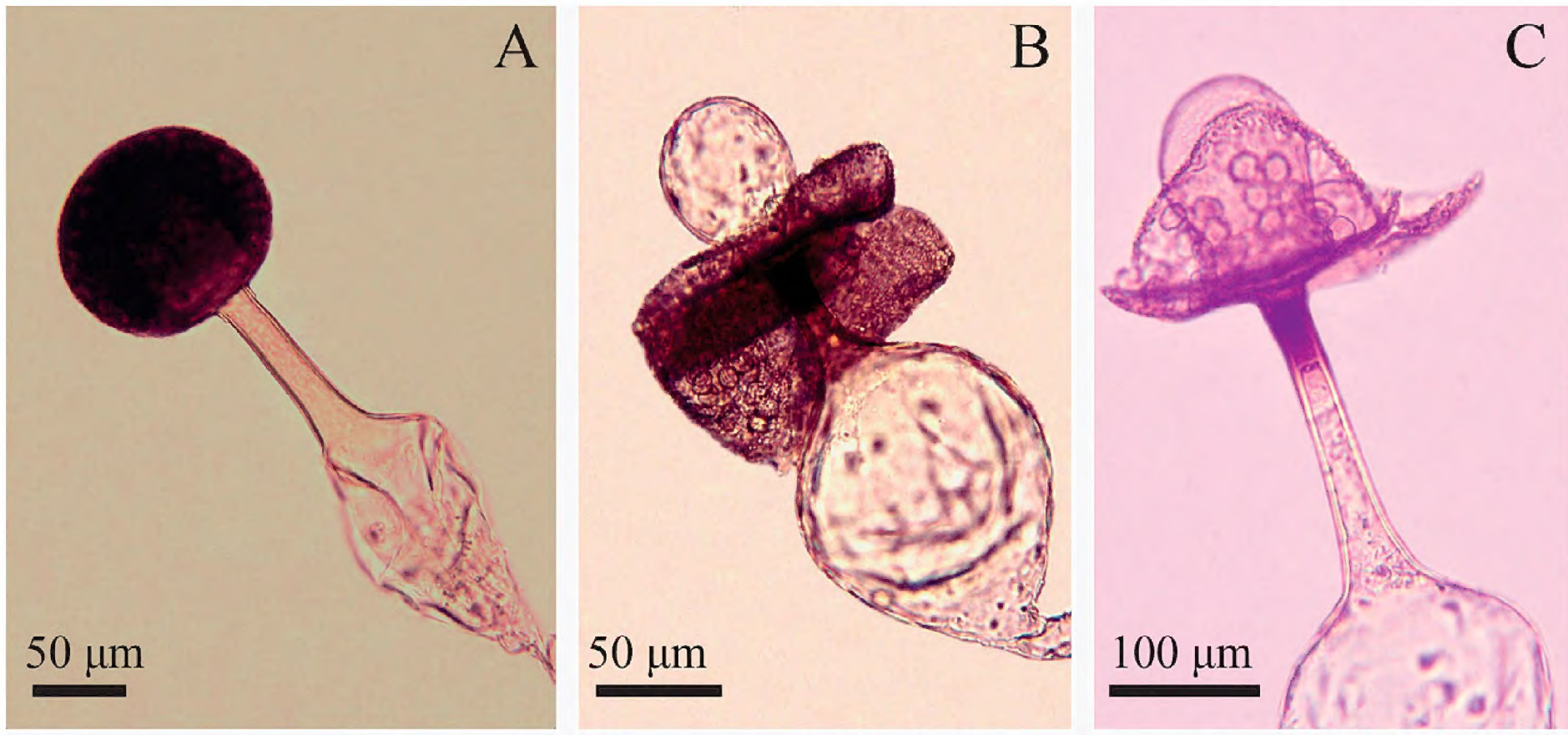

Figure 2. *Utharomyces epallocaulus*. **A.** Sporangiophore with vesicle (withered) and mature sporangia. **B, C.** Sporangiophore with vesicle and columellae. **D.** Trophocyst. **E.** Sporangiospores.

25–55 × 30–50 µm. Pedicels between the subsporangial vesicles and the sporangia hyaline, some brown, 30–90 × 5–12 µm, thick-walled. Sporangiospores subhyaline to greenish at the edges, globose to subglobose, 5–8 (–10) × 4.8–7.2 (–10) µm, verrucose in the central portion. Zygospores not observed.

Discussion

Here, we report the first occurrence of *Utharomyces epallocaulus* in Brazil, specifically from rabbit dung. So far, this species has been reported in North, Central, and South America, Africa and Asia, from the dung of horse (Dring 1960), mouse, rat (Delgado Avila et al. 2005), nilgai (Bogaerts and Noé 2012), toad, and lizard (Chen and Sung 2018). Although *U. epallocaulus* have been commonly reported on dung (Benny et al. 2016), there are two occurrences of this species, one on soil from India (CBS 329.73) and another in humus from the United States (Wallace and Dickinson 1978).

The characteristics of the described specimen correspond well with the description of Boedijn (1959) from a culture developed on rat dung, and of Kirk and Benny (1980) and Delgado Ávila et al. (2005), both from

cultures grown on malt agar 2%. However, some differences in size and shape of some structures were observed between the specimen described in this study and those reported by other authors. *Utharomyces epallocaulus* URM 8129 formed subglobose trophocysts only, different from the other specimens described that also formed ovoid trophocysts (Boedijn 1959; Kirk and Benny 1980; Delgado Ávila et al. 2005). Furthermore, Boedijn (1959) described elongated trophocysts, while Kirk and Benny (1980) also observed ellipsoid trophocysts. Although trophocysts of the URM 8129 specimen did not exhibit apophysis, Boedijn (1959) reported trophocysts with or without apophysis.

The sporangiophores of the *U. epallocaulus* URM 8129 described here were 8–13.5 µm in diameter, thinner than those reported by Boedijn (1959) and Delgado Ávila et al. (2005), which were 14–34 µm and 10–18 µm diameter, respectively. The subsporangial vesicles of the Brazilian specimen were smaller than those described by Delgado Ávila et al. (2005) (90–165 µm in diameter), Kirk and Benny (1980) (80–200 µm in diameter), and Boedijn (1959) (55–182 µm in diameter).

Sporangia initially globose and becoming hemispherical have been reported for this species (Boedijn 1959; Kirk and Benny 1980; Delgado Ávila et al. 2005). However, the sporangia of our specimen were smaller than those described by Boedijn (1959) (55–132 × 70–170 µm), Kirk and Benny (1980) (75–180 × 65–150 µm), and Delgado Ávila et al. (2005) (75–165 × 60–140 µm). In addition, dolabriform to globose columellae were mentioned by Boedijn (1959) and Delgado Ávila et al. (2005), while Kirk and Benny (1980), in addition to these forms, described obovoid columellae. In terms of size, the Brazilian specimen's columellae were similar to those reported by Delgado Ávila et al. (2005) (22–55 × 15–35 µm). Boedijn (1959) reported larger columellae, 60–120 × 52–82 µm, while Kirk and Benny (1980) reported columellae smaller (16–34 × 12–20 µm) than those of the specimen described here.

According to Delgado Ávila et al. (2005), aerial hyphae are absent in *U. epallocaulus*. The same authors claim that differences in *U. epallocaulus* morphology may occur due to the age of the isolate and culture conditions. Boedijn (1958) and Dring (1960) described aerial hyphae, as were also observed in this study.

This manuscript reports the first occurrence of *U. epallocaulus* in Brazil isolated from rabbit dung, contributing to the knowledge of the geographical distribution of coprophilous Mucorales.

Acknowledgements

We thank the Federal University of Piauí for the support received during our research. The National Council for Scientific and Technological Development (CNPq) provided a scholarship of scientific initiation (PIBIC; PI 4345-2018) and a research grant to MOC and ALCMAS, respectively.

Authors' Contributions

MOC collected the material; MHA identified the species; ALCMAS organized the photos; MOC, MHA and ALCMAS wrote the text.

References

Benny GL (2008) The methods used by Dr. R.K. Benjamin, and other mycologists to isolate Zygomycetes. Aliso 26 (1): 37–61. https://doi.org/10.5642/aliso.20082601.08

Benny GL, Humber RA, Voigt K. (2014) Chapter 8. Zygomycetous fungi: Phylum Entomophthoromycota and Subphyla Kickxellomycotina, Mortierellomycotina, Mucoromycotina, and Zoopagomycotina. In: Mclaughlin DJ, Spatafora JW (Eds) The Mycota. A comprehensive treatise on Fungi as experimental systems for basic and applied research. Systematics and Evolution, Part A. VII. Second edition. Springer, Berlin, 208–250. https://doi.org/10.1007/978-3-642-55318-9

Benny GL, Smith EM, Kirk PM, Tretter ED, White MM (2016) Chapter 5. Challenges and future perspectives in the systematics of Kickxellomycotina, Mortierellomycotina, Mucormycotina, and Zoopagomycotina. In: Li DW (Ed) Biology of microfungi. Fungal biology. Springer, Berlin, 65–126. https://doi.org/10.1007/978-3-319-29137-6_5

Boedijn KB (1959) Notes on the Mucorales of Indonesia. Sydowia 12: 321–362.

Bogaerts A, Noé N (2012). National Botanic Garden Belgium - Myxomycetes. Botanic Garden Meise. https://doi.org/10.15468/eu26i5. Accessed on: 2020-02-12.

Chen C, Sung L (2018). Fungi collection in BCRC. Version 1.2. Bioresource Collection and Research Center (BCRC). https://doi.org/10.15468/otmwif. Accessed on: 2020-02-12.

Delgado Ávila AE, García LMU, Chávez AJP (2005) *Utharomyces epallocaulus* Boedijn. ex Kirk & Benny. A new record from Venezuela. Revista Científica 15 (2): 159–162.

Dring VJ (1960) *Utharomyces epallocaulus*: Boedijn in Ghana. Sydowia 14: 285–287.

Foos KM, May NL, Beach DL, Pomper M, Sheehan KB, Ruch DG (2011) Phylogeny of Pilobolaceae. Mycologia 103 (1): 36–44. https://doi.org/10.3852/09-314

Greuter W, Mcneill J, Barrie FR, Burdet HM, Demoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Trehane P, Turland NJ, Hawksworth, DL (2000) International Code of Botanical Nomenclature (Saint Louis Code). Regnum Vegetabile. 138. Koeltz Scientific Books, Königstein, 474 pp.

Kirk PM, Benny GL (1980) The genus *Utharomyces* Boedijn (Pilobolaceae: Zygomycetes). Transactions of the British Mycological Society 75 (1): 123–131. https://doi.org/10.1016/S0007-1536(80)80202-6

O'Donnell K, Lutzoni FM, Ward TJ, Benny GL (2001) Evolutionary relationships among mucoralean fungi (Zygomycota): evidence for family polyphyly on a large scale. Mycologia 93 (2): 286–296. https://doi.org/10.2307/3761650

Sarbhoy AK, Singh SN, Agarwal DK (1974) An interesting member of the Pilobolaceae. Transactions of the British Mycological Society 62 (2): 425–427. https://doi.org/10.1016/S0007-1536(74)80055-0

Tedersoo L, Sánchez-Ramírez S, Kõljalg U, Bahram M, Döring M, Shigel D, May T, Ryberg M, Abarenkov K (2018) High-level classification of the Fungi and a tool for evolutionary ecological analyses. Fungal Diversity 90: 135–159. https://doi.org/10.1007/s13225-018-0401-0

Voigt K, Wöstemeyer J (2001) Phylogeny and origin of 82 zygomycetes from all 54 genera of the Mucorales and Mortierellales based on combined analysis of actin and translation elongation factor EF-1a genes. Gene 270 (1–2): 113–120. https://doi.org/10.1016/S0378-1119(01)00464-4

Voigt K (2012) Zygomycota Moreau. In: Frey W. (Ed) Syllabus of plant families—A. Engler's Syllabus der Pflanzenfamilien. Part 1/1: blue-green algae, Myxomycetes and myxomycete-like organisms, phytoparasitic protists, heterotrophic Heterokontobiota and Fungi. Borntraeger Science Publishers, Berlin, 130–162.

Wallace B, Dickinson CH (1978) Peat Microfungi in three habitats in the Florida Everglades. Mycologia 70 (6): 1151–1163. https://doi.org/10.1080/00275514.1978.12020332